

Captive Propagation: A Progress Report

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Of 291 mammal species and subspecies listed by IUCN as rare or endangered, 162 have been reported in zoo collections since 1962, and 73 have reproduced at least once. Only a few of these, however, have captive populations which seem reasonably secure in terms of numbers and reproduction rates.

THE FIRST ZOO TO PROPAGATE a species in captivity earns a mark of distinction. In recent years, there have been fewer such events than in the past. Many species once thought impossible to breed in captivity have been bred. Others that reproduced rarely now do so more often.

On balance, zoos are still consumers rather than producers of wildlife. A few zoo directors have protested this statement, but available vital statistics confirm it. A typical report from a leading zoo shows:

	Births & Hatchings	Deaths	Net
MAMMALS	156	178	- 22
BIRDS	252	433	-181
REPTILES, AMPHIBIANS, ETC.	0	318	-318

Further, births and hatchings are not evenly distributed over the species in a collection. Among the birds, for example, a few species usually account for most hatchings.

A few zoos are net producers. By and large, these have specialized in their collections. Game parks, game farms, and establishments devoted to breeding waterfowl or upland game birds usually produce annual surpluses.

That zoos might become survival centers for endangered species is not a new idea. Proposing that a national zoo be established, in 1889, Smithsonian Secretary Samuel P. Langley de-

clared it would be "a home and a city of refuge for the vanishing races of the continent." As more and more species approach extinction, interest in survival centers has increased. Citing the Przewalski horse and wisent as examples, some zoo directors assert that captive breeding will be the last hope for many species.

It seems timely to consider what has been accomplished thus far. Because the preceding table is typical, we have limited this review to mammals. The IUCN Red Data Book lists 291 mammal species and subspecies as rare or endangered. In 1962, the International Zoo Yearbook undertook the first of its annual censuses of rare species in zoos. Since that time, 162 of the 291 species and subspecies have been represented in collections. IZY reports of births indicate that 73 of these produced offspring at least once in the ten-year period.

To simplify analysis, we chose two base years, 1962 and 1965, and from the 73 species and subspecies selected those with captive populations of ten or more in either year. This is a crude method of choice; a herd of eight could be a good breeding base, while two dozen widely scattered would not be. However, on reviewing the species and subspecies thus eliminated, we saw no serious omissions for purposes of this study.

There were 41 mammal species and subspecies with base-year populations of ten or more. The 1971 IZY Census showed population increases for 36 of them. This is not, in itself, evidence of breeding success, since the IZY Census does not report acquisitions from the wild. Further, the number of zoos reporting to IZY increased.

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IZY does report the numbers of captive-born individuals within each year's totals. When this data is assembled, there are strong indications of whether a captive population is self-sustaining.

(In the following tables, a blank for 1962 may mean zero response. However, some species and subspecies have since been added to the Census list.)

ZOO POPULATIONS OF RARE AND ENDANGERED SPECIES: 1962-1971

	1962	1965	1971	Captive-born No.	Percent
MARSUPIALIA					
Yellow-footed Rock Wallaby (<i>Petrogale xanthopus</i>)	4	52	46	42	91
Long-nosed Rat Kangaroo (<i>Potorous tridactylus</i>)	5	13	23	8	35
White-throated Wallaby (<i>Macropus parma</i>)	—	19*	180	70	39
*Not reported by IZY in 1965. Data for 1966.					
PRIMATES					
Black Lemur (<i>Lemur macaco</i>)	32	25	73	28*	38
Red-fronted Lemur (<i>Lemur fulvus rufus</i>)	3	10	43	15*	35
*Number of captive-born not reported by Tananarive.					
Mongoose Lemur (<i>Lemur mongoz mongoz</i>)	22	59	167	64	38
Red Uakari (<i>Cacajao rubicundus</i>)	8	32	38	4	11
Goeldi Monkey (<i>Callimico goeldii</i>)	—	10**	16	6	38
**Not reported by IZY in 1965. Data for 1967.					
Golden Lion Marmoset (<i>Leontopithecus rosalia</i>)	—	72***	76	39	51
***Not reported by IZY in 1965. Data for 1966.					
Orangutan (<i>Pongo pygmaeus</i>)	205	349	539	152	28
Bonobo Chimpanzee (<i>Pan paniscus</i>)	9	22	21	4	19
CARNIVORA					
Maned Wolf (<i>Chrysocyon brachyurus</i>)	7	11	65+	22	34
Spectacled Bear (<i>Tremarctos ornatus</i>)	13	43	85+	16	19
Brazilian Otter (<i>Pteronura brasiliensis</i>)	10 min	10 min	15	3	20
Brown Hyena (<i>Hyaena brunnea</i>)	5	32	49	17	35
Asiatic Lion (<i>Panthera leo persica</i>)	3	37	66+	22+	33
Siberian Tiger (<i>Panthera tigris altaica</i>) (Includes Korean form)	—	120	296+	153+	52
Sumatran Tiger (<i>P. t. Sumatrae</i>)	—	23	78+	59+	76
North China Leopard (<i>Panthera pardus japonensis</i>)	—	29	51+	44+	86
Snow Leopard (<i>Panthera uncia</i>)	22 min	54	98	31	32

	1962	1965	1971	Captive-born No.	Percent
PERISSODACTYLA					
Przewalski Horse (<i>Equus przewalskii</i>)	85 min	121 min	182	181	99
Onager (<i>Equus hemionus onager</i>)*	62	113	139+	74	53
*Including animals reported as <i>E. h. hemionus</i> . This combination was initiated by IZY in 1966.					
Indian Wild Ass (<i>E. h. khur</i>)	3	11	11	1	9
Nubian Wild Ass (<i>Equus asinus africanus</i>)	7	16	17	17	100
Hartmann Mountain Zebra (<i>Equus zebra hartmannae</i>)	54	72	91+	37+	41
Baird Tapir (<i>Tapirus bairdii</i>)	6	11	12+	2	17
Great Indian Rhinoceros (<i>Rhinoceros unicornis</i>)	26	39	45+	16	36
Black Rhinoceros (<i>Diceros bicornis</i>)	119	124	128+	28	22
ARTIODACTYLA					
Pygmy Hippopotamus (<i>Choeropsis liberiensis</i>)	49	85	128+	58+	45
Vicuna (<i>Vicugna vicugna</i>)	—	72	69	57	83
Burma Brow-antlered Deer (<i>Cervus eldi thamin</i>)	13	11	37	5	14
Thailand Brow-antlered Deer (<i>C. e. siamensis</i>)	—	12*	10	9	90
*Paris Zoo herd identified as <i>C. e. eldi</i> in IZY 1965.					
Tule Elk (<i>C. canadensis nannodes</i>)	—	14	32	17	53
Formosan Sika (<i>C. nippon taiouanus</i>)	—	306	374+	336+	90
Pere David Deer (<i>Elaphurus davidianus</i>)	130	436	550	550	100
Anoa (<i>Anoa depressicornis</i>)	—	23	24	7	29
Wisent (<i>Bison bonasus</i>)	132	234 min	303+	232+	77
Arabian Oryx (<i>Oryx leucoryx</i>)	5	27	75+	49+	65
Scimitar-horned Oryx (<i>Oryx tao</i>)	18	23	141	101	72
Addax (<i>Addax nasomaculatus</i>)	20	63	142	116	82
Arabian Gazelle (<i>Gazella gazella arabica</i>)	—	10 min	44+	19+	43
<i>Ovis orientalis</i> omitted because of apparent changes in subspecies identification.					

These 41 cases include a wide range of situations. The Przewalski horse story is familiar. At the other extreme, the Brazilian otter is obviously insecure. In between are a number of species which show promising trends but, as yet, provide more reason for hope than confidence.

Our purpose was to identify those situations where zoo propagation has been sufficient to give reasonable assurance that a species can be permanently maintained without further acquisitions from the wild. As a beginning, we chose two arbitrary factors: a 1971 captive population

of 100 or more, and at least half of these captive-born. While these factors alone could not guarantee long-term security, it is unlikely that anything less would.

Using these two factors as a screen, only eight species or subspecies qualified: the Siberian tiger, Przewalski horse, onager, Formosan sika,

Pere David deer, wisent, scimitar-horned oryx, and addax. The mongoose lemur (*Lemur mongoz mongoz*) is a possible candidate for this list; of the two principal collections, one did not report, while the second did not report numbers of captive-born.

1. SIBERIAN TIGER	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	36	41	49	50	51	66	71	77
Total population	104	116	149	162	191	224	248	296
Captive bred	73	66	87	109	140	161	192	253
Percent captive bred	70	57	58	67	73	72	77	85
Births (surviving)	21	28	28	43	58	59	75	—*
Individuals per collection	3	3	3	3	4	3	3	4

*IZY reports births for the year preceding the Census.

The number of individuals per collection remained almost static during the years the population increased by 185 percent. The number of births increased slightly more rapidly than the total population.

In the years shown, 312 successful births were

reported. The total population increased by 192, the population of captive-born individuals by 180. The number of wild-caught individuals increased from 31 to a peak of 63 in 1969, and has since declined to 43. The apparent birth rate has increased.

2. PRZEWALSKI HORSE	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	24	29	33	35	40	41	43	42
Total population	118	121	149	147	157	160	161	182
Captive bred	116	120	148	146	156	159	160	181
Percent captive bred	98	99	99	99	99	99	99	99
Births (surviving)	18	12	18	19	19	14	27	—
Individuals per collection	5	4	5	4	4	4	4	4

This species is often mentioned as a prime example of survival in zoos. The total population has shown a slow but steady increase. The

number of zoos having the species has also increased. The average number of individuals per collection remained constant.

3. ONAGER*	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	26	33	38	39	32	37	43	44
Total population	89	113	135	150	118	132	145	139+
Captive bred	34	34	61	76	65	56	77	74
Percent captive bred	38	30	45	51	55	42	53	53
Births (surviving)	6	18	15	14	13	14	14+	—
Individuals per collection	3	3	4	4	4	4	3	3

*Includes animals once reported as *E. h. hemionus*.

An apparent population decline occurred in 1968. While there were reporting inconsistencies, losses were also indicated, and the popula-

tion total has yet to regain its 1967 peak, nor has the total of captive-born individuals.

The average number per collection has re-

mained almost static, as has the apparent birth rate. Of the 44 collections reporting in 1971, 11 had only one sex.

The onager position is not yet secure, though there is no immediate reason for alarm.

4. FORMOSAN SIKA	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	21	33	32	29	26	26	24	30
Total population	135	306	260	327	420	414	539	374
Captive bred	113	189	209	234	233	248	361	336
Percent captive bred	84	62	80	72	55	60	67	90
Births (surviving)	49	46	65	70	38	52 min	68	—
Individuals per collection	6	9	8	11	16	16	22	12

There appear to be problems of subspecies identification here. Mountain Home (Texas), a private game ranch, reported 105 *Cervus nippon taiouanus* in 1970, none in 1971. However, it reported 60 *C. n. manchuricus*, all captive-born, in 1970 and an estimated 200 in 1971. The total population shown for 1971 was further affected by lack of a report from Taipeh, which had re-

ported an estimated 150 in 1970.

Total population in all other collections increased by 90 from 1970 to 1971. The average number per zoo declined from 15 to 12; the number of collections increased from 22 to 30.

This subspecies appears to be in a strong position for long-term survival in captivity.

5. PERE DAVID DEER	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	43	44	45	49	51	54	60	63
Total population	410	432	436	452	485	497	525	550
Captive bred	410	432	436	452	485	497	525	550
Percent captive bred	100	100	100	100	100	100	100	100
Births (surviving)	97	87	104	120	102	27	99	—
Individuals per collection	10	10	10	9	10	9	9	9

The apparent decline in births for 1969 was caused by a lack of report from Woburn.

IZY now reports only totals for this species, not individual zoo data, which is available from the studbook. In 1968, last year for the indi-

vidual reports, 60 percent of the population was at Woburn.

This species appears to be in a reasonably secure position.

6. WISENT	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	45	58	64	61	70	82	74	76
Total population	177	234	248	258	249	281	283	303
Captive bred	146	145	154	182	192	193	212	232
Percent captive bred	82	62	62	71	77	69	75	77
Births (surviving)	24 min	31	34	30	47	51	44	—
Individuals per collection	4	4	4	4	4	3	4	4

The total population has increased, the average per collection remaining static. Though the

population increase has been slow, the species seems secure.

7. SCIMITAR-HORNED ORYX	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	7	11	9	10	14	18	23	25
Total population	11	23	22	27	53	92	ca.125	141
Captive bred	8	16	16	15	14	44	73	101
Percent captive bred	73	70	73	56	26	48	58	72
Births (surviving)	4	4	8	5	26	23	29	—
Individuals per collection	2	2	2	3	4	5	6	6

The captive population of the scimitar-horned oryx has increased almost explosively since 1967, leaping from 27 to 141 individuals. From 1967 to 1968, the wild-caught population increased from 12 to 39, reaching a peak of 52 in 1970. Since 1968, the number of captive-bred

individuals has risen from 14 to 101, and the percentage of captive-bred individuals has been rising rapidly. The average number of individuals per collection has also increased. If the trends continue, this species will be in a strong position for the future.

8. ADDAX	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	12	17	18	19	17	21	24	27
Total population	59	63	55	72	75	93	126	142
Captive bred	30	42	32	42	31	58	81	116
Percent captive bred	51	67	58	58	41	62	64	82
Births (surviving)	8	16	15	18	24	29	29
Individuals per collection	5	4	3	4	4	4	5	5

The reported wild-caught population has fluctuated from year to year, reaching a peak of 45 in 1970, declining to 26 in 1971. The captive-bred population has increased rapidly since

1968. While this species has not yet attained the total numbers of the wisent or Pere David deer, the position is becoming stronger.

* * *

In seven of these eight cases, captive breeding seems to have established reasonable security for the species, or nearly so. It is interesting that seven of the eight are hoofed animals, which require more zoo space than most smaller mammals.

When the zoo-by-zoo data is analyzed, it appears that the collections with the largest numbers of a species tend to produce disproportionately large shares of the births. One reason for this is that the general averages are depressed by the number of collections having only one sex. In a number of cases, an increase

in the number of collections is accompanied by an apparent decline in the average birth rate. This may be because a collection just acquiring the species may not have both sexes or it may have acquired a pair not yet of breeding age.

Among the 33 other species in the initial table, a number show promising population increases. Five have total populations of more than 100. For nine others the percentage of captive-bred exceeds 50. We have chosen nine additional cases from the 33, not by formula but because of their special interest:

1. GOLDEN MARMOSET	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	ND	ND	23	27	28	24	23	20
Total population	ND	ND	72	99	102	96	84	76
Captive bred	ND	ND	6	8	19	22	34	39
Percent captive bred	ND	ND	8	8	19	23	40	51
Births (surviving)	5	7	5	10	10	18	11	—
	min							
Individuals per collection	ND	ND	3	4	4	4	4	4

ND=No data available

The population has decreased since 1968. While the percentage of captive-bred individuals has risen sharply, this is not in itself a hopeful sign. Since imports of new stock have been

cut off, this percentage could rise to 100 percent while the number in captivity approached zero.

2. ORANGUTAN	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	96	107	120	141	120	119	117	128
Total population	278	349	389	438	434	455	469	539
Captive bred	37	44	46	55	68	81	112	152
Percent captive bred	13	13	12	13	16	18	24	28
Births (surviving)	6	9	21	19	21	28	30	—
Individuals per collection	3	3	3	3	4	4	4	5

The apparent population increase of 70 in 1971 was largely caused by reporting incongruities.

The percentage of captive-born individuals has been rising slowly, as has the number of births. The apparent birth rate has remained relatively stable since 1966.

Many wild-caught orangutans were acquired within a few years preceding 1967. The wild-caught population outside Indonesia reached a peak in 1967 and is now slowly declining. Thus far, captive births have more than offset this decline, but it will be several years more before the likelihood of survival in captivity can be assessed.

3. SUMATRAN TIGER	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	20	11	27	34	30	30	28	29
Total population	44	23	50	86	66	65	62	78
Captive bred	24	5	24	42	42	42	48	59
Percent captive bred	55	22	48	49	64	65	77	76
Births (surviving)	1	6	7	18	12	9	12	—
Individuals per collection	2	2	2	3	2	2	2	3

While there have been reporting inconsistencies, the population decline following the 1967 peak seems to be real. The wild-caught total has declined from a peak of 44 to 19. The num-

ber of births has not significantly increased. The apparent birth rate over seven years has been substantially below that of the Siberian tiger.

4. SNOW LEOPARD	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	27	28	28	33	39	42	39	44
Total population	49	54	54	64	90	96	93	98
Captive bred	8	4	3	15	15	20	29	31
Percent captive bred	16	7	6	23	17	21	31	32
Births (surviving)	3	1	6	15	7	10	7	—
Individuals per collection	2	2	2	2	2	2	2	2

The population of this species has increased chiefly through acquisitions from the wild. Only a modest increase has occurred since 1968. The number of births does not show an upward

trend. The average number per collection has remained static, at two. Of the 44 collections, 11 had only one sex in 1971.

5. HARTMANN MOUNTAIN ZEBRA	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	21	20	22	28	28	33	34	29
Total population	80	72	78	86	81	94	84	91+
Captive bred	21	24	32	35	36	38	42	37+
Percent captive bred	26	33	41	41	44	40	50	41
Births (surviving)	9	7	14	10	9	9	10	—
					min	min		
Individuals per collection	4	4	4	3	3	3	2	3

Total population has fluctuated only slightly during this period. The captive-bred numbers have changed only slightly since 1967. Of the 29 collections, 10 have only one sex. While 68 successful births were reported, the captive-born population increased by only 16.

6. BLACK RHINOCEROS	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	63	66	72	68	67	72	71	65+
Total population	113	124	132	126	126	136	130	128+
Captive bred	18	16	23	21	21	24	27	28
Percent captive bred	16	13	17	17	17	18	21	22
Births (surviving)	2	6	1	3	6	7	9	—
Individuals per collection	2	2	2	2	2	2	2	2

Total population fluctuated only slightly during the period. There was a modest increase in the number and percentage of zoo-born individuals. While 34 successful births were reported, the zoo-born total increased by only 10. The average number per collection remained static. Of the 65 collections reporting in 1971, 25 had only one sex.

7. PYGMY HIPPOPOTAMUS	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	31	33	38	44	43	47	46	48
Total population	80	85	99	103+	108	124	126	128+
Captive bred	35	38	42	45	44	55	50	58+
Percent captive bred	44	45	42	44	41	44	40	45
Births (surviving)	6	12	7	3	11	5	8	—
Individuals per collection	3	3	3	2	3	3	3	3

This species came close to the arbitrary selection factors: 100 or more individuals, 50 percent or more captive-born. In the period shown, the captive population increased by 48, the captive-born total by 23. The number of births reported during the period was 52.

The percentage of captive-born individuals remained remarkably static. Births averaged 7.4 per year, the actual number fluctuating from year to year. The apparent birth rate tended to decline. The average number per zoo remained static.

8. VICUNA	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	28	32	ND	ND	23	20	22	22
Total population	69	72	ND	ND	64	70	70	69
Captive bred	34	38	ND	ND	43	53	44	57
Percent captive bred	49	53	—	—	67	76	63	83
Births (surviving)	7	4	7	4	10	3	5	—
						min		
Individuals per collection	2	2	—	—	3	4	3	3

The percentage of captive-bred individuals has risen, but total population has not increased. The number of births has fluctuated from year

to year. Nine of the collections have only one sex.

9. ARABIAN ORYX	1964	1965	1966	1967	1968	1969	1970	1971
No. zoos reporting	4	4	5	5	6	5	4	4
Total population	27	27	39	49	44	48	58	75
Captive bred	2	7	10	9	9	18	18	49
Percent captive bred	7	26	26	18	20	38	31	65
Births (surviving)	2	3	3	1	5	4	6	—
		min	min					
Individuals per collection	7	7	8	10	7	10	15	19

The increase from 1970 to 1971 in the number of captive-bred individuals is distorted by the report from Qatar, which failed to report this item in 1970, but reported 21 captive-bred animals in 1971. The significant increase is in the captive-bred totals for Phoenix and Los Angeles: from 18 in 1970 to 28 in 1971. For these

two collections alone, the percentage of captive-bred individuals was 62 in 1970, 74 in 1971.

The total captive population has increased rapidly, with a significant increase in the average number per collection. Births show an upward trend.

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On the record to date, zoos have not become a significant resource in the preservation of rare or endangered mammals. Seven species or subspecies endangered or extinct in the wild appear to have reasonably secure captive populations with potential for reintroduction. In a few other cases, favorable trends give promise of security in the near future. While these are important contributions, their number is small by comparison with IUCN's long and growing list.

several years. Then, if the male or female is lost, no replacement may be readily at hand. Further, many zoo directors report difficulty in finding takers for their surplus. They might prefer to send their animals to excellent zoos that emphasize breeding, but such discrimination may not be possible. One zoo deliberately prevented matings of an endangered species because its pens were overcrowded by the previous year's surplus.

The data also indicate that zoos can become a more significant resource. The chief deficiency is managerial, not scientific. Zoos have learned, over the years, how to keep most species alive and healthy in captivity, and how to breed them. Many of these species would undoubtedly multiply to satisfactory numbers if adequate breeding groups were brought together under proper conditions. While some species now present special problems, such as inadequate second-generation reproduction, most should be responsive to concerted efforts.

The capacity of zoos is limited, and most still emphasize diversity in collections. A random selection of ten leading zoos shows an average number of individuals per mammal species of 3.9, the range being from 3.1 to 4.6. Since this average includes over-age individuals, non-breeders, and juveniles, there are, inevitably, many situations without breeding potential.

The troublesome problem is that many species which reproduce adequately under good management do not have self-sustaining captive populations.

Increased propagation of endangered species is feasible, but it may be stifled or become futile unless progeny can be accommodated in their natal zoos or in others willing and able to further propagation. Room for growing numbers must be found, either by displacing more common species or by establishing rural survival centers.

That many zoos report only single males or single females is only part of the problem. A zoo with one of each does not necessarily have a breeding pair. The problem centers in the zoos that do the best job of propagation but, for lack of space, are compelled to dispose of offspring. Too often these offspring are sent to zoos with lesser resources and qualifications, zoos that may wish them only for exhibition.

LITERATURE CITED

INTERNATIONAL ZOO YEARBOOK

1963-1972. Zoological Society of London, London, England

RED DATA BOOK

1966. Volume I. Mammalia. Noel Simon, ed. International Union for the Conservation of Nature and Natural Resources, Morges, Switzerland

A breeding pair may produce offspring for